The Effects of Short Term Flotation REST on Relaxation: A Controlled Study

Gregg D. Jacobs, Robert L. Heilbronner, and John M. Stanley

Lawrence University

The purpose of this study was to compare the effects of restricted environmental stimulation using a flotation tank (Flotation REST) to the effects of a normal sensory environment on relaxation. All of the subjects were first introduced to a simple relaxation program to be used during the experimental sessions. The program consisted of guided point-to-point relaxation, breathing techniques, and visual imagery techniques. Subjects were then pre-tested on measurements of electromyogram (EMG), galvanic skin response (GSR), peripheral skin temperature, and systolic and diastolic blood pressure. The experimental group experienced ten 45-minute sessions practicing the relaxation program in a Flotation REST environment. The control subjects practiced the same relaxation program in a similar body position for 45 minutes in a normal sensory environment. All subjects answered a five-question Subjective Relaxation Questionnaire on trials five through ten and were then post-tested on EMG, GSR, skin temperature, and blood pressure. The results indicated significant differences between groups from pre-test to post-test on systolic and diastolic blood pressure; the experimental group showed greater reductions. Significant differences also were observed on three of five questions on the Subjective Relaxation Questionnaire; the experimental group reported greater subjective relaxation and trends in a similar direction on the remaining two questions. The results of this study indicate that flotation REST enhances point-to-point relaxation, breathing techniques, and visual

Requests for reprints should be sent to John M. Stanley, REST Laboratory, Lawrence University, Appleton, WI 54912.

Gregg D. Jacobs is currently employed with St. Elizabeth Hospital, Appleton, Wisconsin. Robert L. Heilbronner is a Ph.D. candidate at the University of Health Sciences, Chicago Medical School.
imagery techniques and, when combined with these techniques, can be an effective means of teaching normal subjects to lower systolic and diastolic pressure and heighten their subjective perception of relaxation.

INTRODUCTION

Excessive stimulation of the sympathetic nervous system by environmental stimuli has been associated with the pathogenesis of several modern stress-related health disorders including systematic arterial hypertension (Gutmann & Benson, 1971; Patel, 1973) and other disorders (Pelletier, 1977; Selye, 1976). It has been suggested that stress-related health disorders may be prevented or alleviated either by reducing the frequency of sympathetic activation or by increasing parasympathetic activation (Benson, Greenwood, & Klemchuk, 1975). Currently, biofeedback and other self-regulatory techniques are being employed to teach control over sympathetic and parasympathetic functioning. The present study examines a relatively new method of self-regulation involving restricted sensory stimulation.

Early research on the effects of restricted sensory stimulation on human subjects revealed a host of negative reactions, including lapses of attention, deterioration in logical thought, and hallucinations (Bexton, Heron, & Scott, 1954; Heron, Bexton, & Hebb, 1953). Later studies suggest that these negative reactions could be understood primarily in terms of negative experimental set (Pollard, Uhr, & Jackson, 1963), duration of isolation (Zuckerman, 1969), and demand characteristics (Orne & Sheibe, 1964). Recent studies eliminating negative expectancies, providing comfortable settings, and employing shorter exposure durations have yielded much more benign reactions (Lilly, 1977). The most frequent results have been an openness to new information and suggestion, increased awareness of internal cues, lower arousal, and attentional shifts (Suedfeld, 1980; Zubek, 1969). Such outcomes are not only inconsistent with the earlier studies, but actually suggest potential benefits from the Restricted Environmental Stimulation Technique (REST), as it has come to be known. For example, research by Suedfeld has shown REST to be beneficial as a component in treatment for reducing smoking (Suedfeld & Ikard, 1974), snake phobias (Suedfeld & Buchanan, 1974), and weight reduction (Borrie & Suedfeld, 1980).

We proposed to undertake a controlled experiment to investigate the physiological effects of flotation in a sensory isolation tank (Flotation REST) on relaxation. Studies by Wallace and Benson (1972), Chandra Patel (1973), K. K. Datey (1969), and Anand, China, and Singh (1961) have indicated a positive correlation between a variety of meditative techniques and a set of physiological responses characteristic of relaxation (decrease in EMG levels, decrease in GSR, decrease in both systolic and diastolic blood pres-
sure, and an increased incidence of alpha patterns on EEG). Our intention was to examine the possibility of using a flotation REST environment in conjunction with guided relaxation, breathing techniques, and visual imagery as a means of enhancing relaxation. Our hypothesis was that, with a positive experimental set and brief time exposure, subjects who practiced a guided relaxation program in a flotation REST environment would achieve greater relaxation than subjects who practiced the same program for the same time and in the same body position but in a normal sensory environment. Our operational definition of relaxation was based on measurements of frontalis EMG, blood pressure, skin temperature, and galvanic skin response. The flotation technique we employed involved a shorter duration of sensory isolation than in either the early sensory deprivation studies or the more recent Chamber REST research and a more complete reduction of sensory stimuli (cf. Shurley, 1960).

METHOD

Subjects

The subjects were the first 28 respondents to an advertisement placed in the Lawrence University newspaper asking for volunteers to participate "in a 10-week psychology experiment." Because of the size of the school (Lawrence University is a private liberal arts college of 1150 students), the majority of those responding to the advertisement knew the experimenters and could surmise that the flotation REST tank was involved, though responses to a debriefing questionnaire indicated that the participants had no further knowledge of the details of the experiment. Thirty-six persons responded to the ad; the first 28 respondents were selected as subjects and the remaining eight respondents were signed up as alternates. The group consisted of 22 males and six females, ranging in age from 18 to 35 years; 11 males and three females were randomly assigned to the experimental group, and an equal number of males and females were randomly assigned to the control group. During the course of the experiment three subjects (two control and one experimental) had to withdraw due to time conflicts.

Apparatus

The Experimental Condition: Flotation REST

The experimental room was located in the basement of the University administration building. The Flotation REST chamber used was similar to the polyurethane foam tank described by Lilly (1977). The dome of the
tank, 55 inches high and five inches thick, was constructed by spraying foam onto an inflatable mold made of construction grade polyethylene sheeting. The tank contained a 10-inch deep solution of epsom salts, table salts, and tap water that resulted in a 20% solution saturation ($D = 1.30$ g/cc). The solution was maintained at a constant temperature of 93.5 degrees F (±.5 degrees F) by a solid state water bed heater with thermostatic control. The Flotation REST environment excluded all light and greatly reduced sound, gravity, and temperature sensations; the subjects floated in a supine position with their ears submerged. The water was cleaned after every use by a diatomaceous earth water filter and was purified by the occasional addition of pool chlorine. A shower facility was installed in an adjacent room for hygienic purposes.

**The Control Room**

The control room was housed in a basement area identical to the experimental one. A 10 x 10 foot cubicle was created by hanging curtains from the ceiling to the floor in order to conceal the outer appearance of the room. Windows were covered to eliminate outside light. A 65-watt light bulb was used for interior illumination and a space heater was employed to maintain a temperature of 74°F. The cubicle was furnished with a desk, chair, bed, and pillows to simulate a bedroom with normal auditory, visual, and temperature sensations. Subjects relaxed in a supine position on a firm mattress.

**Physiological Measurements**

A Biofeedback Systems Model DT-1 digital temperature unit was used to obtain measurements of skin temperature. Response was determined by thermistor probes attached by micropore tape to the first digit of the middle finger (palm side). A battery operated Biofeedback Systems Model EDR-2 electrodermal response unit was used to obtain measurements of galvanic skin response. Phasic change was set to a level of 50% and velcro finger electrodes were placed on the first segment of the fore and ring fingers (palm side). A Biofeedback Systems Model B-2 unit was employed to obtain measurements of EMG. This featured a band pass of 95-1000 Hz, noise subtracted. The headband was situated so that the middle sensor was placed approximately one inch above the eyebrows in the middle of the forehead. In order to amplify the muscle potentials from the EMG sensors, a Biofeedback Systems Model PA-2M preamplifier was utilized. A Tycos precalibrated Model No. C74 sphygmomanometer (pressure cuff, hand pump, release gauge, and pressure dial) was used to measure the blood pressure. All blood pressure measurements were taken with subjects in a sitting position.
Procedure

**Briefing and Pre-Tests**

Subjects were seen on an individual basis for briefing sessions regarding the experiment in the last week of September at Lawrence University. They were told that the purpose of the study was to examine the subjective effects of meditation on relaxation. Experimental subjects were instructed that they would experience ten 45-minute sessions in a REST environment. Control subjects were told that they would experience ten 45-minute sessions in a normal sensory environment followed by one 45-minute session in a REST environment. The final REST session for the control group was not part of the actual experiment; it was included in the experimental description to mask the existence of a control group because some subjects did sign up for the experiment because they thought the use of the REST tank was involved. All participants were asked to comply with a silence agreement throughout the duration of the study. Informed consent forms and psychophysiological checklists were completed and subsequently reviewed by the experimenters. Two days following the briefing, all subjects attended a group meeting at Lawrence University where they were taught a relaxation program to be used in their respective environments. This consisted of modified progressive relaxation, breathing techniques, and mental imagery. Subjects were taken through the program twice; however, no attempt was made to encourage further practice on their own.

Subjects were pre-tested twice to get an average measurement on each physiological parameter. These tests were conducted during the next two weeks at St. Elizabeth Hospital Stress Laboratory, a distance of 1.6 miles from the University. Each individual was instructed to rehearse the relaxation program while he was being monitored to insure consistency across all subjects. All participants were told that the purpose of the measurements was to establish that a normal EEG, body temperature, and blood pressure were present in order to satisfy the health requirements of our study. EMG, GSR, and skin temperature measurements were taken every minute for 15 minutes. Blood pressure readings were taken immediately after the other physiological measurements. Blood pressure measurements were taken twice to insure accuracy. One experimenter recorded blood pressure for each subject; another experimenter recorded EMG, GSR, and skin temperature. Individual means for EMG, GSR, and temperature were based on the average of the 15 one-minute readings. To arrive at a pre-test mean for each individual, the first and second means were averaged together. For systolic and diastolic blood pressure, individual pre-test means were obtained by taking the average of the two pre-test readings; post-test scores were obtained in a similar manner. The experimenters were not blind to the con-
ditions of the subjects, a fact that might or might not have had some influence on the measurements.

**Experimental Trials**

After pre-testing, each subject spent ten 45-minute relaxation sessions in his respective environment at intervals ranging from three to five days. All subjects were told they should rehearse the relaxation techniques for a minimum of 25 minutes. Beyond this suggestion no attempt was made to influence or monitor the subjects' behavior and no additional cues of any kind were given. After the 45 minutes had elapsed, the experimenter returned and asked the subject to record his experience on a cassette tape, commenting on any physical or mental sensations, thoughts, feelings, and so on, that occurred during the session. Marked differences between groups in the verbal reports were noted consistently on trials one through four; consequently, beginning with trial five and continuing through trial ten, we administered a Subjective Relaxation Questionnaire to all subjects in both groups. The questionnaire consisted of five questions regarding subjective feelings of relaxation; subjects responded to each question on a five-point rating scale. They read as follows:

1. How would you rate your experience in terms of overall relaxation?
2. Which of the following situations would best express your feelings during your experience? (Falling from a high cliff; going to the dentist office; watching TV; curling up in bed at night; lying on the beach on a warm sunny day.)
3. How did the muscles in your body feel during your experience?
4. To what degree did you feel you had control over your thoughts?
5. At what rate did your thoughts come and go?

**Post-Testing and De-Briefing**

Upon completion of the tenth session, subjects were informed that they must return to the hospital for post-experiment check-ups in order to insure a good state of health before conclusion. These post-test measures were identical to those given six weeks earlier. After post-test, a de-briefing session was held at which all 25 subjects who finished the experiment answered, in writing, questions about the purpose of the study, their relaxation techniques, and so on. This debriefing session indicated that all subjects accepted the original cover story; that they had no knowledge of the actual purpose of the experiment, including the check-ups given at the hos-

---

1Copies of any of the questionnaires used in the study may be obtained by writing to the authors.
pital; and that only one subject practiced relaxation skills outside of the experimental setting. In addition, all subjects reported that the initial 20–30 minutes of each session was spent performing the relaxation techniques taught by the experimenters and that the remaining time was spent on various activities including furthering their relaxation skills, problem solving, personal growth, and so on.

Design

The experimental design was a mixed design: The between subjects variable was the experimental versus the control group; for the within subjects variable pre-test and post-test measures were compared. The dependent measures were EMG, GSR, peripheral body temperature, and systolic and diastolic blood pressure.

RESULTS

Dependent Measures

The results indicated significant differences between groups on measurements of systolic and diastolic blood pressure and on three of five questions (No. 2, No. 4, No. 5) on the Subjective Relaxation Questionnaire. Although an analysis of variance indicated a significant difference between groups on EMG measurements, a subsequent analysis of covariance revealed no significant differences in post-treatment means. Galvanic skin response was not used in the results due to technical difficulties with the equipment. No significant difference was observed for skin temperature, though both groups showed an anomalous decrease in skin temperature.

Systolic Blood Pressure

The pre-test mean for the experimental group was 122 millimeters of mercury; the post-test mean was 114 millimeters of mercury. The pre-test and post-test means for the control group were 122 millimeters of mercury and 119 millimeters of mercury, respectively. There was a significant trial × condition interaction, $F(1,23) = 4.84, p < .05$; the experimental group showed a greater reduction from pre-test to post-test. A planned comparison on the two post-test means indicated a significant difference between groups, $t(23) = 2.60, p < .05$; the experimental group’s mean was lower. Planned comparisons were also performed on the pre-test and post-test means within each group; the experimental group showed a significant reduction from pre-test to post-test, $t(23) = 2.08, p < .01$. 
Diastolic Blood Pressure

The pre-test mean for the experimental group was 66.1 millimeters of mercury; the post-test mean was 55.3 millimeters of mercury. The pre-test and post-test means for the control group were 69.4 millimeters of mercury and 63.0 millimeters of mercury, respectively. Here also there was a significant trial × condition interaction, $F(1,23) = 4.89, p < .05$; the experimental group showed a greater reduction from pre-test to post-test. A planned comparison was performed on the two post-test means indicating a significant difference between groups, $t(23) = 4.84, p < .01$; the experimental group's mean was lower. Planned comparisons also were performed on the pre-test and post-test means within each group; the experimental group showed a significant reduction from pre-test to post-test, $t(23) = 6.31, p < .01$; the control group also showed a significant reduction from pre-test to post-test, $t(23) = 3.36, p < .05$.

Subjective Relaxation Questionnaire

Individual scores for each question were obtained by assigning numerical values to each of the five possible choices, that is, 1 was assigned to choice A, 2 to choice B, up to a 5 for choice E. A group mean for each question was computed by averaging all subjects' scores across trials 5–10. An analysis of variance performed on each question revealed significant differences between groups for question No. 2, $F(1,24) = 5.09, p < .05$, question No. 4, $F(1,24) = 5.09, p < .05$, and question No. 5, $F(1,24) = 9.09, p < .05$; the experimental group reported greater relaxation. The group means for questions No. 2, 4, and 5 for experimental and control groups respectively were: 4.48/4.02; 3.77/3.10; 3.40/2.64. A correlational analysis of the means for questions No. 2, 4, and 5 suggested that these three questions were not intercorrelated (all r's values < .23). Although questions No. 1 and No. 3 did not yield significant differences, they indicated trends in a similar direction; the experimental group reported both greater general relaxation and more overall muscle relaxation. (The group means for questions No. 1 and No. 3 for experimental and control groups respectively were: 4.45/4.18; 4.49/4.17.)

EMG

The pre-test mean for the experimental group was 10.7 microvolts, whereas the post-test mean was 7.1 microvolts. The pre-test and post-test means for the control group were 7.8 microvolts and 8.2 microvolts, respectively. A significant difference was indicated between groups on the trial × condition interaction, $F(1,23) = 4.51, p < .05$, the experimental group showing a greater reduction from pre-test to post-test. A subsequent
planned comparison on the two pre-test means indicated a significant difference between groups, \( t(23) = 2.18, p < .05 \), the control group's mean being lower. Planned comparisons also were performed on the pre-test and post-test means within each group; the experimental group showed a statistically significant reduction from pre-test to post-test, \( t(23) = 2.66, p < .05 \). Since, however, the pre-test mean for the experimental group was unusually high, an analysis of covariance was used to test the two post-test means. This analysis indicated no significant difference between post treatment means.

**Skin Temperature**

Individual means were obtained by using the same method used for EMG. An analysis of variance indicated no significant differences between groups on skin temperature, but, interestingly, both groups showed a decrease from pre-test to post-test.

**Galvanic Skin Response**

The galvanic skin response data were not used in the statistical analysis because the experimenters used faulty recording procedures.

**Subjective Accounts**

**Reported Experiences**

Although the only systematic subjective data collected were from the Subjective Relaxation Questionnaire, the taped recordings of post-session interviews did reveal a number of commonly reported experiences that were analyzed by the experimenters. The experimental group reported slightly more frequent alterations in temporal and spatial orientations and some auditory distortions. The control group reported sleeping 27% of the time as compared with only 9% by experimental subjects.

**Debriefing Questionnaires**

In the debriefing sessions at the end of the experiment, all subjects were asked to respond to 26 questions designed to detect any adverse side effects and to note the effect of the experiment on general health, relaxation, and concentration. Sixteen questions were addressed to general health and adverse side effects, five questions to relaxation, and five questions to concentration. Three of the questions addressed to relaxation showed no significant differences between the responses of the control group and the experimental group. However, in the open-ended question that asked the
subjects to list specific beneficial effects that have carried over from the experiment to their everyday life, relaxation was mentioned specifically 12 times by the experimental group compared with five times by the control group. There were no indications of adverse side effects for either group.  

DISCUSSION

The results support the hypothesis that, with a positive preparatory set, comfortable setting, and a duration of 45 minutes, subjects who practiced relaxation skills in a flotation REST environment would achieve greater levels of relaxation than subjects who rehearsed the same skills in a normal sensory environment. While it is difficult to ascertain the exact role of experimental set, setting, time exposure, and relaxation skills in relation to flotation REST, it is clear that, in the combination we employed, flotation REST was more conducive to relaxation than a normal sensory environment. This is evident in that the experimental group showed significantly greater reductions from pre-test to post-test on systolic and diastolic blood pressure and reported greater subjective relaxation as compared with the control group. The hypothesis is also supported by the within-group comparisons of pre-test and post-test means of both systolic and diastolic blood pressure in which the experimental subjects showed significant reduction on both measures as compared with control subjects who showed significant reductions on only one measure, diastolic blood pressure. The hypothesis is further substantiated by the between group comparisons of post-test means on systolic and diastolic blood pressure in which the experimental group’s means were lower. It should be noted that both the significant differences between groups and the substantial diastolic decrease (11 millimeters of mercury) on the part of the experimental subjects were observed using relatively small sample sizes and few experimental trials.

The physiological data are further supported by the responses to the Subjective Relaxation Questionnaire in which the experimental group reported greater relaxation on three of five questions and similar trends on the remaining two questions. The responses to the debriefing questionnaire, in which the experimental subjects explicitly mentioned relaxation as a benefit of the experience more than twice as often as the control subjects, further substantiated the physiological results.

The results of the blood pressure comparisons are especially intriguing. While our experimental data were derived from a volunteer normo-tensive

2Copies of this and other questionnaires used in the study may be obtained by writing to the authors.
population, several recent case studies (Fine & Turner, 1982; Kristeller, Schwartz, & Black, 1982; Suedfeld, Roy, & Landon, 1982) indicating clinically significant reductions in blood pressure among hypertensives, suggest the possibility that our experimental results may be generalizable beyond a normo-tensive population. Kristeller, Schwartz, and Black (1982) have suggested a mechanism that may explain how the REST technique was effective in reducing blood pressure among hypertensive patients. These authors argue that because the hypertensive individual is completely removed during REST from external sources of stress, the high “set-points” that exist in hypertension may re-regulate themselves to a lower, more homeostatic level via a complex psycho-physiological system of multiple feedback loops. A similar mechanism may also partially explain the experimental results obtained with our normo-tensive population. In addition, quite possibly the REST environment could have served the purpose of strengthening the effects of the cognitive relaxation program by increasing concentration on the particular techniques themselves. In this manner, a cognitive physiological feedback loop could have been established whereby physiological alterations could result from increased concentration and attentional abilities.

Although these mechanisms can serve to explain the results, certain other neurophysiological processes underlying these mechanisms cannot be overlooked. Lindsley (1961) has argued that the neurophysiologic locus of the effects of sensory deprivation may well be in the brainstem, specifically in the reticular formation. This is the anatomical part of the brain responsible for arousing the cortex and transmitting information to the autonomic nervous system via the hypothalamus (Rothballer, 1956); it also monitors and directs the environmental stimuli that enter the nervous system (French, 1957). It may be that a restricted sensory environment decreases the activity level of the reticular activating system and, subsequently, the cortex and hypothalamus, which are integral to the stress reaction in response to external stimuli. It has also been proposed by Galambos (1956) that the reticular activating system participates in the selective alteration of information prior to cortical registration. Information that does not reach consciousness is still registered subcortically and can affect behavior, including subcortical activation of the sympathetic nervous system. It may be that, as Pelletier and Garfield (1976) have shown in their treatment of deep relaxation and imagery therapies, flotation REST allows the individual access to those stimuli that have been registered subcortically, thus terminating conflict between cortical and subcortical processes.

There were a few unexpected outcomes of this study. For instance, one would think that sleep would be a natural consequence of the decreased sensory input to the cortex from the reticular formation, but there appears to be little support for this in the present study. The control subjects reported
sleeping on 27% of the trials, whereas the experimental subjects reported falling asleep on only 9% of their trials. The little time spent sleeping by the experimental subjects could have been due to a number of factors such as the novelty of the situation and initial anxiety from the first few trials. It is also possible that the prevalence of “internal stimuli” for example, vivid imagery, clear thoughts, louder heart beat, may have been sufficient input into the reticular formation to result in the maintenance of a relaxed but awake state.

Secondly, the results in skin temperature were not consistent with the differences noted on other physiological measures. It is unclear at this point why. One possible explanation is that the post-tests were done in early December, whereas the pre-tests were done in early October. Because subjects were some distance from the lab where the measurements were taken, the change in environmental temperature from October to December may have affected the mean readings of peripheral skin temperature.

Finally, it is unclear at this point why the control group showed significant decreases only on the within-group comparison of pre-test and post-test means on diastolic blood pressure and not on systolic blood pressure or EMG.

The results of this study indicate that Flotation REST in conjunction with a guided program of relaxation techniques seems to be effective in reducing blood pressure in a normo-tensive population. These results combined with recent case studies on the effects of Chamber REST and Flotation REST on essential hypertension indicate that REST is applicable to the treatment of hypertension which is of increasing concern in the field of behavioral medicine. Future researchers may want to compare the effects of Flotation REST to both Chamber REST and traditional biofeedback training.

ACKNOWLEDGMENTS

This study is based on research carried out at Lawrence University by Gregg D. Jacobs and Robert Heilbronner under the direction of John M. Stanley in the fall and winter of 1979-80. The authors are grateful to Bruce E. Hetzler, James Sweeney, and Robert E. Christiaansen of the Lawrence University Psychology Department; Jeff Bruno, REST and Self-Regulation Institute, Toledo, Ohio; and David Lansky, University of Health Sciences/Chicago Medical School for advice in research design and interpretation of data; to Lawrence University and St. Elizabeth Hospital, Appleton, Wisconsin for assistance in preparation of the manuscript; and to Dale Druckery of Appleton, Wisconsin, for assistance in construction of the flotation REST tank.
REFERENCES


